May 18, 1948. H. J. NICHOLS 2,441,939

FUSE

Filed Nov. 14, 1939

Fig. 1

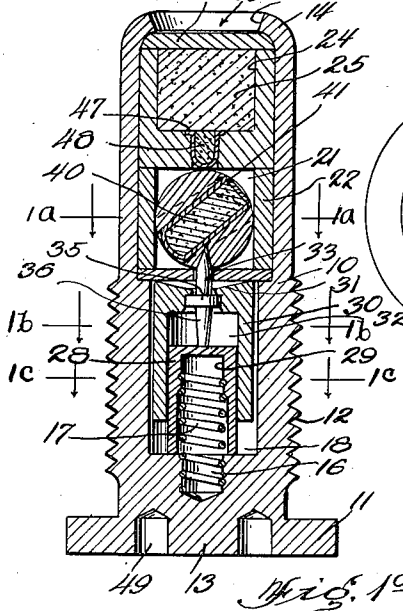


Fig. 3

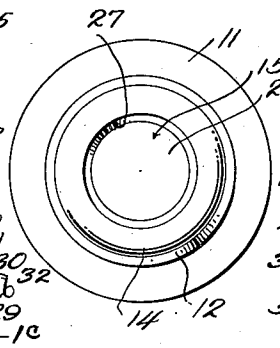


Fig. 2

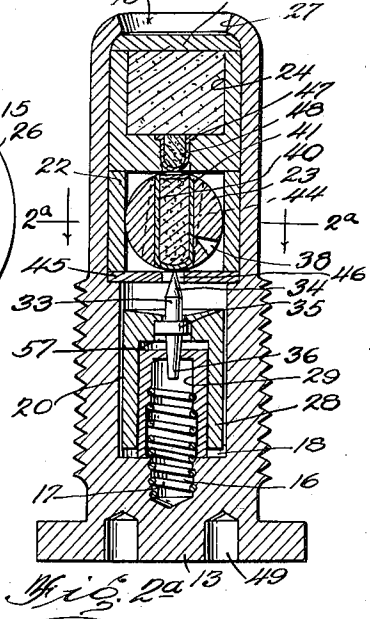
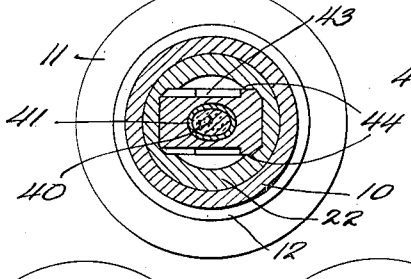


Fig. 1a



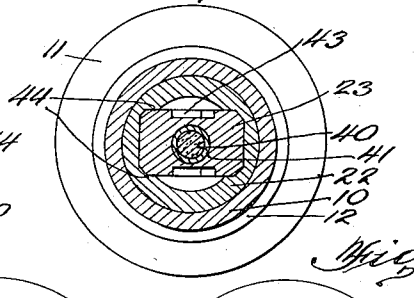
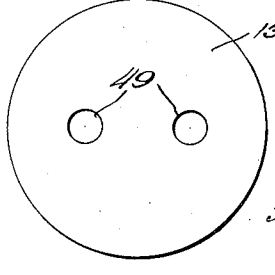
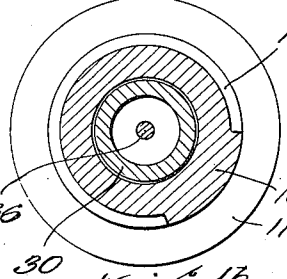


Fig. 1c





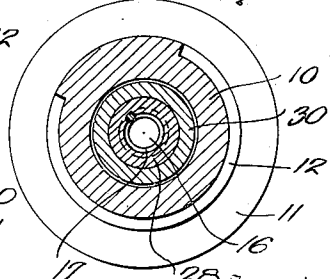


Fig. 4

Fig. 1b

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Patented May 18, 1948

2,441,939

UNITED STATES PATENT OFFICE

2,441,939

FUSE

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Application November 14, 1939, Serial No. 304,394

9 Claims. (Cl. 102—80)

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This invention relates to base detonating fuses, especially adapted for use with anti-tank projectiles and other small caliber high-explosive projectiles intended for use against armored or protected targets.

The invention will accordingly be hereinafter described with relation to such application but it is to be understood that without material modification many features are equally applicable to larger caliber projectile fuses.

Detonating fuses for small high explosive projectiles present particular difficulties because of their small size, the great accelerating and rotary forces to which the parts are subjected in firing and in flight, and the heavy forces encountered at impact. Because of the desire to obtain maximum penetration of armor, a nose fuse, which would necessitate weakening the front end of the projectile is generally considered undesirable and a base fuse is preferred. Because of the extreme force of "set-back," on firing some projectiles the detonator may be fired by concussion. Also the detonator may be subject to accidental explosion by fire while the fuse is in storage, transport, or service. These hazards make it highly desirable that the fuse be "detonator-safe", by which term is meant that the detonator be held in safe position in the fuse until the projectile has cleared the muzzle. A further desirable feature is that the fuse be not completely armed until the projectile has travelled some distance beyond the muzzle of the gun. This is termed a "muzzle-safe" feature. In order to insure certain arming and sensitivity, it is highly desirable that the percussion device be virtually dynamically balanced with respect to the axis of rotation of the projectile in flight, which is also the axis of the fuse.

Finally, from the practical standpoint, fuses of this class should be simple in construction, easily loaded and assembled, and adapted to low cost manufacture in large quantity.

It is therefore one of the principal objects of this invention to meet in a highly efficient, reliable, and practical manner the general and special requirements above stated.

Another object is to provide simple and rugged arming means which utilize forces generated by the firing process, but which are not affected adversely thereby, nor by the forces and shocks incident to handling.

Another object is to provide a high degree of safety against premature explosion in handling the fuse, or on firing the loaded and fused projectile.

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Another object is to provide means for delaying the arming of the detonator until after the projectile is in flight, or "muzzle-safe" feature.

Another object is to provide a novel and effective "bore-safe" and "detonator-safe" construction as a precaution against concussion or fire hazards.

Another object is to provide simple and practical means for cushioning the shock on the detonator on firing.

Another object is to provide simple arming means for the detonator which after rotating the detonator is inherently incapable of being thrown from armed position by forces produced by impact with the target.

Other objects will in part be obvious from the annexed drawings and in part hereinafter indicated in connection therewith by the following analysis of the invention.

This invention accordingly consists in the features of construction, combination of parts, and in the unique relation and coordination of the members and in the relative proportioning and disposition thereof, all as more completely outlined herein.

To enable others skilled in the art fully to comprehend the underlying features of this invention, that they may embody the same by the numerous modifications in structure and relation contemplated by the invention, drawings depicting a preferred embodiment of the invention form a part of this disclosure, and in such drawings like characters of reference denote corresponding parts throughout the several views, in which—

Fig. 1 shows greatly enlarged, in longitudinal section a base percussion detonating fuse of small size according to the invention, the mechanism being shown in unarmed or safe condition.

Figs. 1*a*, 1*b*, 1*c* are cross section views of Fig. 1 at planes indicated by lines *a*—*a*, *b*—*b*, and *c*—*c*.

Fig. 2 is a similar section, showing the mechanism in armed condition after firing.

Fig. 2*a* is a cross section view of Fig. 2 at the plane indicated by line *a*—*a*, showing the rotor cross section in armed position.

Fig. 3 is a top or inner end view of the fuse.

Fig. 4 is a bottom or base view of the fuse.

Referring now to these drawings and especially to Fig. 1, the main member of the fuse is the body 10 of rugged proportions with flange 11 and external screw threads 12 near the base end 13 for assembly to the projectile (not shown). The body 10 is bored out from the point end 14 to provide an internal bore 15 in which the mechanism is assembled. Starting at the base 13, a

small axial bore or cavity 16 is threaded to receive the lower portion of an anti-creep spring 17. A middle bore or cavity 18 is adapted to house a percussion plunger 20, to be described in detail later. The nose cavity 21 is adapted to receive a rotor sleeve 22, mounting a rotary detonator holder or centrifugal rotor 23, and also a booster cup 24, containing a booster charge 25 of compressed tetryl or the like. The point end 14 of the fuse is closed by a sealing disc 26, over which a lip 27 of the fuse body is spun, or otherwise closed or constructed to form a tight seal. The parts 22 and 24 may be die-cast integrally, if desired.

The percussion plunger 20 comprises a support or pedestal 28 having an internally threaded cavity 29 adapted to receive the upper portion of anti-creep spring 17, the threads being bored out for a short distance at the mouth of cavity 29 to enable the middle coils of spring 17 to stretch without interference with the screw threads. The purpose of this spring 17 is to prevent the percussion plunger 20 from being thrown forward after firing when the projectile strikes the atmosphere, and during flight.

The percussion plunger includes element 30 of hollow cylindrical form, which is substantially closed at the top 31, and has an internal cavity 32 fitting easily over the pedestal 28. Mounted in the axis of the element 30 is a firing pin 33 comprising a firing point 34, a collar 35 and a slightly tapered punch 36 at the opposite end. Collar 35 is securely set in a recess 37 in the element 30 by riveting the edge of the recess over the collar. Punch 36 rests on top of pedestal 28, which latter is of such thicknes that when the fuse is fired, the "set-back" force on element 30 and firing pin 33 will cause the punch 36 to pierce the top of the pedestal 28 and to remain securely wedged therein due to the taper on the punch (see Fig. 2).

The rotor sleeve 22 is of hollow cylindrical form with a rectangular hole adapted to receive the rotor 23, the latter being of short cylindrical form and lying edgewise in rotor sleeve 22. The rotor has a diametrical round hole adapted to receive a cylindrical detonator capsule 40. The detonator capsule is preferably a thin drawn copper shell, in which a highly compressed detonating charge is loaded. The assembly of the detonator is completed by covering the detonating charge, loaded not quite to the top, by a thin disc 41 cemented in place by a water proof cement. When the detonator capsule 40 is loaded into the rotor, it is coated with a strong adherent cement to hold the capsule securely in place in the rotor 23. The rotor is provided with a small tapered hole 38 (Fig. 2), located at an angle of approximately 45° to the axis of the detonator 40, this hole being adapted to receive the point 34 of the firing pin 33 when the rotor is in safe position as shown in Fig. 1.

The rotor 23 is of centro-symmetric form, being of the type disclosed in my application Serial No. 303,294, filed November 7, 1939, so that while it is virtually statically ballanced as it lies in the rotor, it is strongly dynamically unbalanced with respect to rotation about the axis of the fuse, which is likewise substantially the axis of rotation of the projectile while in flight.

Referring to Fig. 2*a*, on each end of the rotor 23 a central channel 43 may be cut at slight inclination to the axis of the detonator 40. This leaves two symmetrical lands 44 on each end of the rotor, of segmental shape, which lands produce the dynamic unbalance. The dynamically

unbalanced areas are indicated by the portions between the dotted lines and periphery of the holder as shown in Fig. 2. There is also some minor unbalance due to the detonator capsule and the firing pin hole 38, but the rotative effect produced thereby is generally too small to be material, and for purposes of understanding the principle of the rotor, the lands 44 may be considered to produce the main and effective rotative effect. The slight inclination of these lands to the axis of the detonator hole, previously mentioned suffices to compensate for minor unbalance and friction, so that after firing the axis of the detonator is aligned substantially with the axis of the fuse. It has been found that the channel separating the lands can be parallel to the axis of the detonator in most cases.

Referring again to Fig. 1, between a shoulder 27 in the bore 15 of the fuse body 10 and the rotor sleeve 22 is assembled a disc 45, termed the support disc, of thin elastic metal arranged to cushion the shock on the detonator 40 on firing, thereby minimizing the possibility of premature detonation due to concussion. The disc 45 is provided with a small axial hole 46 thru which the point 34 of firing pin 33 normally extends to engage the hole 38 and restrain the rotor in safe position.

The booster cup 24 is mounted between the rotor block 22 and sealing disc 26. It is provided with a small diameter axial hole 47, counter bored at the upper end to receive a small metal cup 48, called the cord protector cup. The interior of the cup is filled with tightly compressed cord or tetryl or the like for transmitting the detonation from the detonator to the booster charge 25. The purpose of the cup 48 is to protect the cord from moisture, and also from hot gases likely to be produced in event of premature explosion of the detonator 40.

The fuse is assembled into the projectile by spanners engaging recesses 49 as shown in Figs. 1 and 4. Then the operation is as follows: On firing, all parts tend to move towards the base 13 due to "set-back." The element 30 carrying firing pin 33 is affected by this force, and moving backward drives the punch 36 thru the top of pedestal 28 and causes the same to wedge therein, securely attaching these parts as shown in Fig. 2. The firing pin 34 is thereby drawn from the hole 38 in the rotor 23 and the rotor would be free to arm then except that the "set-back" force presses the rotor tightly against disc 45. The rotative force due to dynamic unbalance being minor compared to the "set-back" force, the rotor is prevented from rotating and remains in the position shown in Fig. 1 as long as the projectile is in the bore of the gun.

It should be noted here that not only is the rotor 23 and detonator 40 cushioned against the shock of firing by disc 45, but in the event the detonator is exploded despite this cushioning or by fire, the effect of the detonator explosion will be to expand the rotor and to wedge a plug of metal from the rotor into the hole occupied by the protector cup 48 securely sealing same against the entry of hot gases. The protector cup 48 will shield the tetryl cord from mechanical shock to a degree sufficient to prevent deflagration. The hot gases from the detonator will expand into voids in the fuse, including the space over the plunger 30, and will be cooled and rendered harmless by such expansion.

The possibility of the acceleration of the projectile being reversed in the bore of the gun due

to coppering or other obstruction also requires consideration. In such event, the elasticity of the disc 45 will cause the rotor 23 to rebound therefrom and strike the booster cup before it can respond to rotative forces, and if the percussion plunger 20 is propelled forward, the firing pin 34 will strike the rotor 23 and retain the detonator in safe position. Hence it is evident that the invention provides adequate safeguards against premature explosion of the detonator before firing and while the projectile is in the bore of the gun, and the fuse can be properly termed "bore-safe."

Referring to Fig. 2 as to position of the percussion plunger 20, and to Fig. 1 as to position of the rotor 23, as the projectile leaves the muzzle of the gun, and the force of the propellant becomes spent, the acceleration of the projectile ceases, and deceleration due to air resistance occurs. At this instant, disc 45 will throw the rotor forward, but after rebound, the rotor is free to arm, and at the same time the rotation of the projectile due to firing is a maximum, hence the unbalanced forces cause the rotor to turn into the position shown in Fig. 2. The fuse is now completely armed and at some safe distance beyond the muzzle of the gun. The tendency of the percussion plunger 20 to pitch forward due to air-resistance, termed "creep," is countered by the anti-creep spring 17.

On striking a target, the projectile will encounter substantial resistance, and will be checked in flight. This brings into play strong decelerating forces, and the percussion plunger 20 will be propelled forward, overcoming the anti-creep spring 17 and stabbing the firing pin into the detonator, exploding same. The wave of detonation therefrom will travel through the tetryl cord 48 and booster charge 25 to the projectile burster charge, not shown but assumed to be of high explosive, whereby the projectile is fragmented.

It is to be noted that when the rotor 23 is in armed position shown in Fig. 2, the dynamic unbalance no longer exists, but there remains a torque couple holding the rotor in armed position and there is no tendency towards, nor possibility of, the rotor being thrown out of armed position while the projectile is in flight. Furthermore, on impact with an obstruction, due to the cylindrical shape of the rotor, inertia forces cause the rotor to wedge tightly in its mounting structure, and it cannot be thrown out of armed position by any combination of impact forces. This is of importance in connection with oblique impact, particularly against armor plate, under which circumstances strong random forces are applied to the fuse, and if the rotor can be thrown out of position, incomplete detonation or a "dud" may result. The rotor of the invention is therefore "self-locking" in the armed position.

While no particular provision is made to obtain delay in bursting after impact, it is known that by incorporating in the detonator capsule special retarding compositions, a short delay burst can be obtained without material modification of the fuse.

It will be evident to those skilled in the art that the embodiment of the invention, shown and described as a detonating fuse, can be readily converted into an ignition fuse by simple modifications, such as substituting a cap or primer for the detonator, a port or powder pellet for the tetryl cord, and a charge of powder for the tetryl booster. Such modifications properly come, and

are so intended, within the scope of the invention as claimed.

Without further analysis the foregoing will so fully reveal the gist of this invention that others can, by applying current knowledge, readily adapt it for various applications without omitting certain features that, from the standpoint of the prior art, fairly constitute essential characteristics of the generic or specific aspects of the invention, and therefore such adaptations should and are intended to be comprehended within the meaning and range of equivalency of the following claims.

I claim:

1. In a base detonating percussion fuse, in combination, a fuse body having an axial bore, and detonating means assembled therein including a booster holder with a booster charge sealed therein, a stationary element having a cavity with a centrifugally rotatable detonator holder mounted rotatably therein, a detonator mounted in said holder in safe position, a percussion element for exploding said detonator including a firing pin positioned rearwardly of and in restraining engagement with said holder, means for enabling said firing pin to move rearwardly to armed position when said fuse is fired in a gun, and means for restraining forward movement of said percussion element in flight.

2. In a base detonating percussion fuse, in combination, a fuse body having an axial bore, and detonating mechanism assembled therein including a booster holder containing a booster charge, a stationary member with a cavity having a centrifugally rotatable cylindrical detonator rotor mounted rotatably therein with its axis at right angles to the axis of the fuse, a cylindrical detonator mounted diametrically in said rotor in safe position, a percussion element mounting a firing pin for exploding said detonator slidably mounted in said bore rearwardly of said rotor, means including said firing pin for maintaining said rotor in safe position until said fuse is fired in a gun, and means for sealng said mechanism in said body.

3. In a projectile fuse of base detonating percussion type, in combination, a fuse body having an axial bore, sealing means therefor, and an assembly of mechanism sealed therein including symmetrical rotor means carrying a detonator assembled in safe position, rotor means self-rotatable responsively to centrifugal force for turning said rotor means and detonator from safe to armed position when the projectile is in flight, and setback armed percussion means including a firing pin positioned rearwardly of and in restraining engagement with said rotor means for exploding said detonator on impact of the projectile with the target.

4. In the combination set forth in claim 3, said percussion means including a pair of elements normally maintaining said firing pin in restraining engagement with said rotor means, said elements telescoping when the fuse is fired in a gun to remove the restraint of said firing pin on said rotor means.

5. In detonating mechanisms for base detonating percussion fuses, in combination, a fuse body having an axial bore, and detonating means assembled therein including a centrifugally rotatable detonator carrier mounting a detonator and located with its center of gravity substantially on the axis of said bore, a percussion element positioned rearwardly of said carrier including a firing pin for holding said carrier in inoperative

position until said fuse is fired in a gun and thereafter for exploding said detonator on impact with a target, and means for normally holding said firing pin in engagement with said carrier.

6. In a base detonating percussion fuse, in combination, a fuse body having an axial bore, and detonating mechanism assembled therein including a stationary member with an axial cavity having a centrifugally rotatable cylindrical detonator rotor rotatably and concentrically mounted therein, a detonator mounted diametrally in said rotor at the center of gravity thereof, a percussion element positioned rearwardly of said rotor including a firing pin for exploding said detonator, set-back actuated safety means forming part of said percussion element for normally holding said firing pin in restraining engagement with said rotor, and anti-creep means for restraining said percussion element from forward movement when armed.

7. A detonating percussion fuse for a rotative projectile having, in combination, a fuse body adapted for assembly into such a projectile having an axial bore and closing means therefor, and an assembly of exploding mechanism enclosed therein comprising, a centrifugal detonator rotor carrying a cylindrical detonator mounted therein transversely to the axis of said bore, a percussion device including a movable firing pin positioned axially and in rotation preventing engagement with said rotor, and means for releasing said rotor for centrifugal rotation when the projectile carrying said fuse is discharged from a gun.

8. A base detonating percussion fuse for a rotative projectile having, in combination a fuse body adapted for assembly into such a projectile having an axial bore and closing means therefor, and an assembly of detonating mechanism enclosed therein comprising, a centrifugal detonator rotor of circular main section with a detonator mounted in a diametrical bore therein and transversely to the axis of said body, stationary means for rotatably mounting said rotor, an inertia percussion plunger including a firing pin for exploding said detonator positioned axially in rotation preventing engagement with said rotor, and an anti-creep device arranged to restrain movement of said plunger towards said rotor during flight of said projectile.

9. A base detonating percussion fuse for a rotative projectile having, in combination, a fuse body adapted for assembly into the base of a projectile and having an axial bore with closing means therefor, and exploding mechanism assembled therein comprising, a holder containing an explosive booster charge, a detonator for initiating the explosion of said charge normally safely positioned in a rotor, a centrifugally operated detonator rotor for turning said detonator from safe to armed position responsively to the spin of said projectile, an inertia percussion plunger including an axially movable firing pin normally positioned to prevent rotation of said rotor to armed position, and anti-creep means for restraining said plunger from movement towards said rotor during flight of the projectile.

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